R E P O R T R E S U M E S

ED 015 498 CG 001 059

PROMOTING CREATIVE THINKING IN THE CLASSROOM--THE PROCESS OF CURRICULUM DEVELOPMENT.

BY- COVINGTON, MARTIN V.

EDRS PRICE MF-$0.25 HC-$1.40 33P.

DESCRIPTORS- *CURRICULUM RESEARCH, *CREATIVE DEVELOPMENT, *CREATIVE TEACHING, *PROBLEM SOLVING, GRADE 5, GRADE 6, CURRICULUM DEVELOPMENT, CREATIVE THINKING, CREATIVITY RESEARCH, PRODUCTIVE THINKING, EDUCATIONAL PSYCHOLOGY, PSYCHOLOGICAL TESTS, *PROGRAMED INSTRUCTION, AUTOINSTRUCTIONAL AIDS, COMPUTER ORIENTED PROGRAMS, MATCHED GROUPS, GENERAL PROBLEM SOLVING PROGR., MINNESOTA TESTS OF CREATIVE THINKING

A GENERAL, PROBLEM-SOLVING PROGRAM (GPSP), CONSISTING OF 16 CREATIVE PROBLEMS FOR THE FIFTH AND SIXTH GRADE LEVELS PRESENTED IN A SELF-INSTRUCTIONAL LINEAR FORMAT, WAS DEVELOPED AS A PROTOTYPE OF INSTRUCTIONAL LINEAR MATERIALS ON CREATIVE PROBLEM SOLVING. THROUGHOUT THE SERIES OF LESSONS, A STORY LINE IS MAINTAINED TO GIVE THE READER A SET OF IDENTIFICATION MODELS. IT GRADUALLY INTRODUCES HIM TO THE PROCESS OF BECOMING A MORE EFFECTIVE THINKER. IN SEVERAL STUDIES, 267 FIFTH AND SIXTH GRADE STUDENTS WERE GIVEN THE GPSP WHILE 214 FIFTH GRADERS SERVED AS CONTROLS. ALL STUDENTS WERE PRETESTED AND RECEIVED MODIFIED TRADITIONAL PROBLEM SOLVING TESTS. THE MINNESOTA TEST OF CREATIVE THINKING SERVED AS THE CRITERION TEST BATTERY. HIGHLY CONSISTENT RESULTS INDICATE THAT INSTRUCTED STUDENTS OBTAIN SUPERIOR SCORES ON ALL INDICES OF PROBLEM SOLVING AND CREATIVE THINKING. FOLLOW-UP STUDIES PROVED LESS CONCLUSIVE. A FUNDAMENTAL QUESTION IS WHETHER PROGRAMS DESIGNED TO PROMOTE CREATIVE THINKING ARE NECESSARY. FUTURE RESEARCH WILL INVOLVE EXPANSION OF THE GPSP AND THE DEVELOPMENT OF NEW UNITS ON UNDERSTANDING AND CREATIVE INNOVATION. RESEARCH IS ALSO BEING DIRECTED TOWARD ADAPTING GPSP FOR COMPUTER PRESENTATION. THIS PAPER IS TO BE INCLUDED IN N.J. KLAUEMEIER (ED.), "CONTEMPORARY RESEARCH OF SIGNIFICANCE TO EDUCATION," UNIVERSITY OF WISCONSIN, IN PRESS. (PR)

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
OFFICE OF EDUCATION
THIS DOCUMENT HAS BEEN REPRODUCED EXACTLY AS RECEIVED FROM THE PERSON OR ORGANIZATION ORIGINATING IT. POINTS OF VIEW OR OPINIONS STATED DO NOT NECESSARILY REPRESENT OFFICIAL OFFICE OF EDUCATION POSITION OR POLICY.

ED015498

Promoting Creative Thinking in the Classroom: The Process of Curriculum Development[1,2]

Martin V. Covington
University of California, Berkeley

The last decade has seen a sharp increase in the volume of research on creativity and creative thinking with a major focus on isolating the basic processes of creative thought (Mednick, 1962; Mandelsohn & Griswold, 1964) and on identifying the unique characteristics of creative persons (MacKinnon, 1965; Barron, 1964; Crutchfield, 1963). Despite such unprecedented interest in creativity, until quite recently there has been relatively little research on the general problem of nurturing and promoting creative thinking, especially in the classroom setting. However, due partly to increased public awareness of the need to husband our intellectual resources, this important topic is beginning to receive the attention and research support it deserves.

The purpose of this paper is to describe part of the research program at Berkeley for developing curriculum programs aimed at promoting the general level of creative thinking among elementary school children and to consider some of the pedagogical implications of such research, especially regarding the value, feasibility and justification of teaching for creative functioning. For a survey of other current research in this area representing differing theoretical and methodological approaches, see Myers and Torrance (1964), Osborn (1953), Parnes (1965), Suchman (1961), Upton and Sampson (1961).

CG 001 059

By way of introduction, it should be noted that most of the current attempts to develop such teaching materials, including that of the Berkeley group, share two fundamental assumptions: (1) that all children, regardless of age or initial intellectual level, fall far short of realizing their potential for creative thought, and (2) that these individuals can be taught to make fuller and more appropriate use of their capacities by means of systematic and direct training of certain cognitive skills.

As for a definition of a creative child (in a real sense the ultimate criterion by which the success of a teaching program must be judged) , it is generally agreed that he is intellectually curious and exploratory, taking an active part in manipulating and reconstructing his environment. To paraphrase a number of current definitions:

> The creative child prefers to explore the unknown, rather than to conserve the already known; he prefers explaining facts in new ways, rather than continuing to rely on traditional well-established explanations; he indulges in adventuresome thinking and raises questions, rather than being content with things as they are.

With these preliminary comments setting the stage, we turn next to more pointed observations about the nature of creative thinking and how best to foster it--observations which to a large degree have determined the specific form and character of the research of the Berkeley group. As a first step, we will identify and discuss several widely-held misconceptions about creative functioning and its facilitation.

Misconceptions Concerning the Nature of Creative Thinking

Perhaps the most commonly held belief concerning creative functioning is that the child will become creative of his own accord--by drawing

on some heretofore latent potential--if only he can be placed in a stimulating yet permissive and nurturing environment. The erroneousness of this view is due not so much to a misreading of the nature of man as it is to an oversimplification of the means by which his latent capacities are to be realized. More specifically, an environment which is at once permissive and stimulating undoubtedly plays an important role in establishing the conditions necessary for creative output, but this is only part of the story. In order to take full advantage of an unrestrictive atmosphere, the child must first come to understand what constitutes creative ideas in the given situation and how he can achieve such ideas for himself. In short, he must learn <u>how</u> to think creatively. In this connection, a growing body of observational and empirical evidence (Hammer, 1961; Holt, 1964; Peel, 1960; Torrance, 1963) indicates that most school children are inadequately prepared for creative thinking. Corroborative data gathered by the Berkeley group at the fifth-grade and sixth-grade level reveals a conspicuous inability among students to think of any ideas, much less clever or novel ones. Moreover, there is little understanding of the nature of originality and virtually no sense of playfulness which is necessary for prolonged effective work on a creative task. Not surprisingly then, one finds that the responses of most children to challenging tasks, even in a permissive environment, are by and large pedestrian and generally lacking in creative merit.

In order to think creatively the child must have at his disposal a repertoire of creative thinking skills. To name a few: the ability to recognize gaps in existing information; a facility at formulating

relevent questions, and a sensitivity to the demands of the task so one can adequately judge the suitability of proposed ideas. The epitomy of creative thought is a sense of "disciplined abandonment." An array of cognitive skills such as those just mentioned constitutes the "discipline" component which must be present in concert with an accepting nurturing environment before the child can take full advantage of such freedom and "abandon" himself to the task at hand. Thus, seen in this perspective, the job of fostering creative thinking is a more complicated undertaking than suspected by many. It is <u>more than</u> merely providing a permissive atmosphere for the release of creative potential; it is <u>more like</u> teaching the child how to make use of his freedom to create.

If one must <u>teach</u> children to think creatively, then what kinds of pedagogical strategies would seem most appropriate? There are no doubt a number of reasonable answers to this question. For example, one approach--the traditional one--is to teach in such a manner that the child will come to act creatively in a number of different subject-matter disciplines. Another contrasting, yet complementary possibility is to teach for a number of cognitive skills fundamental to all creative thinking and then show the student how such generalized skills can be applied in specific subject-matter areas. This latter strategy carries with it the implication of developing curriculum materials whose subject-matter is the creative thought process itself. As we shall see presently, it is this approach which is being explored by the Berkeley group.

Although there is considerable latitude with respect to the variety of reasonable approaches for promoting creative thinking in the classroom, there are limits. Some limits can be established based on our growing knowledge of the dynamics of the creative process. For example, it has been well established that creative thinking is largely dependent on cognitive operations and dispositions of a non-logical character. Yet despite this, the notion as well as the practice persists of teaching for logic and for critical thinking as means for promoting creative functioning. As we shall see shortly, creative thinking, whether it be in science or in the humanities, involves a good deal more than rational and critical analysis, and to teach only for these functions to the exclusion of more imaginal, speculative processes is to fall short of fostering creative thought.

It has been further argued that teaching for scientific methods of thinking will establish a respect for the lawfulness and the simplicity of nature itself. Although the child may indeed infer from such exercises that nature is orderly and lawful, such an understanding may curiously enough act to <u>fetter</u> creative thought. More specifically, as currently taught, elementary school science, the humanities and the social sciences as well, do not always reflect the way scientific investigation and creative scholarship actually happen. Creative contributions to any field of knowledge are made by wrestling with ambiguous conflicting facts and data with the overall aim of bringing conceptual order out of chaos. However, as represented in many current textbooks, the drama of the pursuit of such order and understanding is replaced by an oversimplified, tailored and predigested view of a

disciplines, emphasizing what is already known and stressing the all-encompassing explanatory power of presently accepted theories or laws. Such a simple, clear-cut presentation which smooths over complexity and controversy is designed primarily to make for more efficient learning and retention, rather than to focus on the problem of how the child himself can learn to manipulate a given set of facts, to draw his own conclusions, or indeed to discover new facts, which is after all, one of the primary functions of the creative innovator. There is little question that such textbook presentations will make for the most rapid, untroubled assimilation and mastery of the material, but it should not be assumed that the approach which makes for the most efficient learning will also be most effective in fostering creative and productive thinking.

Moreover, in the way most subject-matter has been traditionally taught, the student is rarely allowed to practice on problems which require innovative modes of thought for their solution. Consequently he has no direct opportunity to learn what constitutes creative ways to manipulate data, nor to develop an intuitive sense for designing research or to ask questions which favor serendipity and maximize the chance for new insights. In short, the child does not acquire the cognitive skills which would be most helpful in preparing him for future productivity.

A specific case in point illustrating the lack of emphasis on thinking creatively about facts and information is the set of so-called "discussion questions" found at the end of many textbook chapters. As commonly used, these questions are not particularly helpful in promoting

creative patterns of thought. Often the student is merely asked to think about these questions with little or no subsequent follow-up discussion of the adequacy of his answers. With minimal dialogue between the student and the teaching authority, the child rarely gets any systematic feedback as to what counts as merely an adequate answer as opposed to an ingenious, novel one. Even in those cases where the teacher finds time to comment on the quality of the pupil's essays, the feedback is inevitably delayed, thus reducing the effectiveness of the exercise. Because the child typically operates from question to question in what is essentially a "cognitive vacuum" with little opportunity to profit from his past efforts, he is unable to develop any internal standards of excellence against which he can evaluate subsequent ideas. In effect this means he is unable to modify his efforts in the direction of more creative and imaginative output.

Another feature of such discussion questions--their placement at the end of the chapter--strengthens the impression that these exercises are simply an appendage, added to the text as an afterthought rather than forming a central part of the learning experience itself. Moreover, their placement occurs at the psychologically inappropriate moment for stimulating productive ideas. By the end of the chapter much of the intellectual tension and drama built up as part of the content presentation will have dissipated, making it difficult to engage further the child's interest. In contrast, the placement of discussion questions should be coordinated with the presentation of the content itself, capitalising on the student's immediate curiosity and momentarily aroused interest.

Recommendations for a Curriculum of Creative Thinking

Recognizing some of these pedagogical deficiencies, what can be recommended with regard to a curriculum for creative thought? The first recommendation is that such a curriculum feature repeated opportunities for the child to practice wrestling with complex challenging tasks of the kind that might, in a more complex form, engage the efforts of creative adults. Of course, such problems (which we shall call "creative-tasks-in-miniature") must be scaled down and simplified in many respects--in particular, reducing their dependence on technical or specific knowledge. Nevertheless, even with various modifications of this type such tasks could still retain the basic elements of any intellectually creative undertaking. A second recommendation is that certain broad guides and strategies for creative thinking be introduced as the child works on these tasks. Such guides would act as points of reference around which the child could organize his work and would impart an atmosphere of planfulness to the process of problem solution.

Next, what can be said more specifically about the nature of these "creative-tasks-in-miniature"--their particular content--and the composition of the accompanying rules and strategies for productive thought? It is sobering to realize that the creative innovators of the year 2000 (only 33 years hence) are to be found in the elementary schools of today. As these individuals stand on the threshold of the 21st century they will be confronted by scientific revelations and social issues literally undreamt of today as well as a large share of old problems left unresolved by previous generations. To meet these challenges the innovator of tomorrow must create new social systems,

new scientific techniques, tools and theoretical structures. To accomplish this he cannot rely on presently fashionable views as to what constitutes fruitful scholarship or good scientific method, nor can we afford to instill in him a blind devotion to currently fertile theories, since much of this theoretical apparatus is already approaching obsolescence. Here then is a compelling argument for the necessity of teaching broad strategies for creative thought and for encouraging cognitive flexibility and intellectual curiosity, rather than merely teaching for what we presently take to be true or useful.

What kinds of tasks could children practice on now to prepare them for their roles as the innovators of the future? Two kinds are suggested: the hypothetical problem and the enduring problem. The former type minimizes reliance on present facts and theories in obtaining a solution, while the latter type focuses on the deathless issues of human affairs which are certain to be the subject of creative reinterpretation and re-evaluation in any future age.

Typically in the case of the hypothetical problem certain artificial conditions are postulated which do not correspond to present realities and the individual is called on to operate within these internally consistent but artificial systems. One problem of this type, which itself has become popular as a measure of creativity, is the consequence test: given certain conditions, such as a world in which time runs backwards, what are all the consequences? Such problems demand cognitive flexibility, imagination and the ability to adopt as temporarily real a set of foreign and unfamiliar assumptions.

At Berkeley we are now drawing up plans for an experimental teaching apparatus which simulates a visit to a strange planet. The student is put in charge of the first exploratory expedition. His job, a highly creative and demanding one, is to come to understand and to explain the welter of strange events which he will encounter in this alien, unfamiliar world where the usual physical, biological and social laws are suspended or greatly modified. Here the child is literally confronted with a hypothetical world which, although it is ordered and internally consistent, operates in ways that run counter to his previous experience. He must suspend his present expectancies about the world as he knows it long enough to create new explanations for strange and perplexing phenomena. Thus by permitting the child to deal with hypothetical tasks which call for the creation of new systems of ideas, independent of present facts and assumptions, he can hedge against the time when these facts will outlive their usefulness and will no longer serve as a basis for productive thought.

Granting the largely unknown course of future events, there are on the other hand certain enduring problems of man and society which are constantly reasserting themselves and no doubt will engage the attention of future creative thinkers. The young student of today can best be prepared to cope with such issues in adulthood by being presented <u>now</u> with repeated opportunities to deal with enduring themes and quandries: to search for new implications and to re-phrase them in contemporary terms. Many of the most suitable teaching examples are found in literature, such as the Greek myth of Sisyphus, dealing with man's reluctance to accept his fate; the tragedy of Frankenstein,

reflecting the consequences of man's age-old dream of creating a more perfect being in his own image; or the mythical Icarus, personifying man's unflagging zeal to explore nature regardless of the consequences. Of course, it is understood that such issues cast in the form of teaching examples would have to be greatly simplified and made appropriate to a child's level of understanding. Notice, however, that such modifications are made easier by the fact that the traditional vehicles for the dramatization of these issues are themselves reasonably constant--the novel, the play and the poem--providing already familiar media through which children can express their ideas. In this connection, we shall presently describe a "creative-task-in-miniature" in which the student creates a play dealing with yet another timeless and recurring theme--the plight of the wrongfully accused.

Finally, what are the sources on which one can draw in formulating a set of broad cognitive skills and strategies which could be taught now to prepare children for future productivity? Information concerning such generalized cognitive strategies can be gleaned not only from laboratory research dealing with complex problem solving and thinking but from anecdotal and life-history accounts of highly creative individuals as well. In the first instance there is a steadily accumulating body of knowledge from the psychological laboratory concerning the kinds of factors, both facilitative and inhibitory, which influence the course and quality of productive thought. One widely documented example is the deleterious effect of rigid mental set on effective problem solving (Luchins, 1942). Here, because the individual initially formulates or perceives a task in a narrow and inherently biasing way, he is

effectively sealed off from attaining a solution. A number of appropriate thinking strategies incorporating these and other research findings can be formulated. For example, with reference to the present example of mental set, the student can be taught to view a problem broadly, to re-phrase questions in new ways, and to resist jumping to premature conclusions.

The other source of cognitive strategies comes from anecdotal descriptions of creative individuals at work (Ghiselin, 1952; Koestler, 1964). A number of insights into the fundamental nature of creative thought have grown out of such observations, as well as the discovery of important phenomena associated with creativity, such as incubation and intuition. As an example, the famous and widely cited self-reports of Poincaré, the French mathematician, have served to focus attention on the conceptually fertile notion of creativity as basically a process of recombining ideas in new and novel patterns. And of most relevance to our immediate concern, such observations have led to the elucidation of a number of specific problem-solving strategies, among them the technique of identifying the essential elements of a problem situation and deliberately juxtaposing them in various ways (Campbell, 1960).

By combining the experimental laboratory approach and its virtues of empirical validation with the rich and broadly inclusive self-reports of the highly creative thinker, one can formulate a set of rules and strategies which are pervasive enough to apply to a variety of creative tasks, but yet simple enough to be readily understood by elementary school children.

Summary

In summary of the first section of this paper it has been argued that before the student can take full advantage of a permissive stimulating atmosphere he must be taught *how* to think creatively. In developing a teaching program for creative thought the single most important pedagogical issue is the long-term social and personal usefulness of what is taught. It has been suggested that one reasonable teaching strategy, in light of this consideration, is to strengthen those cognitive skills basic to all creative thought in the context of complex yet meaningful problems which reflect the principal steps in the creative act. These observations, taken as a whole, have formed the broad guide-lines for the research carried out by the Berkeley group over the past several years.

The Present Research

As a first step it was decided to develop a set of prototype instructional materials dealing with only one aspect of productive thought--creative *problem solving*. If the particular teaching approach showed promise, then other programs would be designed, focusing on yet other domains of creative thought such as creative *innovation* and creative *expression*.

After several years of intensive effort, involving numerous pilot tryouts, successive revisions, and several full-scale experimental studies, the *General Problem Solving Program* was developed (Covington, Crutchfield, & Davies, 1966). The *General Problem Solving Program* (GPSP) consists of a series of 16 "creative-problems-in-miniature"

designed for the fifth-grade and sixth-grade level. These problem episodes act as a vehicle by which the student practices a number of broad rules and strategies concerned with various facets of effective problem solving, such as stating the problem in an open and unbiased fashion, reformulating the problem in terms of familiar metaphors and analogies, or developing a systematic plan for generating ideas.

Each lesson presents a mysterious occurrence or unexplicable happening which the student tries to explain, such as the puzzling behavior of a group of aquanauts during a deep sea dive. This general theme--the mysterious occurrence--was chosen because it encompasses in a natural and uncontrived manner many of the fundamental aspects of the problem-solving process. In addition, such a theme is neutral with respect to orthodox curriculum materials. This makes for a broader transfer of what is taught than might otherwise be the case if the principles and concepts had been associated primarily with a specific content area. Finally, children exhibit a keen interest in working on problem situations featuring a mystery-detection theme.

Each lesson is presented in booklet form and is cast in a self-instructional linear format. (For a theoretical discussion of the potential uses of programmed instruction for fostering higher-order thought processes, see Crutchfield & Covington, 1965.) Briefly, the child works through the lesson in a step-by-step sequence by himself and at his own pace. As the problem unfolds page-by-page, with the advent of new facts and clues, the student is called on to reformulate the problem in his own words, to list questions he considers crucial to the solution or to devise a plan of action which he intends to

follow. The student receives immediate guidance in his efforts on successive pages of the booklet. This guidance typically takes the form of presenting a range of ideas, questions or courses of action which the student might have thought of in the given situation. Here the emphasis is on encouraging appropriate diversity in the student's thoughts by showing him within wide limits what constitutes valuable ideas, crucial questions and fruitful ways to formulate problems.

The GPSP is also designed to promote beneficial attitudes toward productive thinking. One of the basic strategies is to increase the child's experience in coping successfully with thought problems. Each problem episode is sequenced so that as the student works through the booklet he is exposed progressively to more clues and hints. Thus, each child, independent of his initial capacities or personal reservations about thinking, will at some point come to discover the solution for himself. In addition there is a systematic attempt to foster, by means of appropriate teaching examples, a number of attitudes which favor effective problem solving, such as open-mindedness, persistence and suspension of premature judgment.

A story-line is maintained throughout the GPSP to supply a sense of continuity, and perhaps most importantly, to provide the reader with a set of identification models. The story concerns two school children, Jim and Lila (brother and sister) whose extra-curricular pastime is the exploration of mysterious situations which arise in and around their home town. Jim and Lila are assisted--and when the occasion demands, assiduously directed step-by-step--through these adventures by their uncle. The uncle in addition to being a high school science teacher also "moonlights" as a detective.

The identification-modal technique is intended to introduce the reader gradually to the difficult and often frustrating process of becoming a more effective thinker. For example, the roles of Jim and Lila reflect the vicissitudes associated with all complex problem solving--the long discouraging periods of intense effort with little apparent progress, the inevitable setbacks, and finally, the intellectual elation of discovering a solution. Through Jim and Lila the reader can experience all this vicariously without being plunged immediately into the situation. After the first few lessons, however, the reader is gradually drawn into the various problem-solving activities by being requested to think of and to record his own ideas in concert with the efforts of Jim and Lila--first the student generating his own ideas or questions, then Jim and Lila responding with theirs. The feedback examples provided for the reader are presented as Jim's and Lila's ideas.

Against this backdrop of transitory day-to-day successes and failures, a long-range change takes place in Jim and Lila. They are depicted as overcoming initial handicaps of reticence, apathy and negativism toward thinking until ultimately, but not without an occasional setback, they become reasonably comfortable with their own thought processes, much more enthusiastic about tackling problem situations, and more confident in their own abilities to cope with them. It is hoped that this subtle but perceptible change in Jim and Lila will foster in the reader a sense of his own progressive improvement. At the same time it is intended that as many readers as possible will finally come to surpass Jim and Lila in problem-solving proficiency

and will outgrow any earlier dependence on them as a source of ideas and inspiration.

The inclusion of the uncle provides Jim and Lila, and presumably the reader as well, with a benevolent authority figure and confidant who not only nurtures and encourages the nascent attempts of these tyro-thinkers but who also shows them how to think for themselves by means of appropriate rules and strategies. Additionally, the uncle stands as a valued model personifying an enthusiasm for intellectual exploration.

Each lesson is presented in an illustrated format. Such a dominantly visual presentation not only increases the student's interest in the materials, but makes it easier for him to follow the necessarily complicated dialogue and thought sequences of the story characters. The lessons contain an average of 40 pages and are designed to be presented at a rate of one lesson per day. The average time taken to complete a lesson is approximately 35 minutes.

Several separate studies (summarized in Covington & Crutchfield, 1965) have been carried out using various preliminary editions of the CPSP which to date have involved a total of some 481 fifth-grade and sixth-grade school children from the San Francisco Bay Area, of whom 267 were given the training materials and the remaining 214 were used as controls. The basic design of these studies is essentially the same. All students are first administered an extensive pretest battery (six hours in length in the latest study) which consists of a number of tests of creative thinking (Torrance, 1965), tests of problem-solving ability (Covington, 1966c), inventories designed to measure

the child's attitudes toward problem solving and thinking (Covington, 1966a), and various tests of school achievement and scholastic ability. These data are used as a basis for the initial matching of the classrooms. Individual classrooms are matched in pairs; one classroom from the pair is then assigned at random to the instructed condition and the other to a control condition. In each of the various studies to date, the instructed groups have always been administered the GPSP. In contrast, a number of different control conditions have been used to test various hypotheses about the nature of the training effect. The typical case, however, and the one on which the present analysis is based, calls for the administration of a similar but shorter set of self-instructional materials whose content is unrelated to problem solving. The purpose of the control program is to insure a sense of involvement and participation on the part of the control children and to make certain that they are well acquainted with the self-instructional format. Following the training period all classes are administered a posttest battery, which includes a repeat of the attitude inventories and the tests of problem-solving ability along with parallel forms of the tests of creative thinking.

Several examples will suffice to illustrate the general types of tests included in the pretest and posttest batteries--their content, style, and degree of similarity to the training material. One type reflects the more traditional tests of problem solving. In these instances, because of a large number of restrictions placed on the task, there is only a limited set of answers or principal solutions which will satisfy the problem in its entirity. Here an emphasis is placed

both on convergent and divergent thinking. The student is called on to diverge in his search for appropriate ideas--opening up a host of possibilities--but at the same time to converge, focusing on the few most suitable ideas. A representative example is the X-ray problem (a modification of the classic problem used by Karl Duncker, 1945). The child is required to invent a method to kill a tumor deep inside a body by using an X-ray but without harming the surrounding healthy tissue. The primary constraint is that if the X-ray is too strong it will kill both the healthy tissue and the tumor. If, on the other hand, the X-ray is made too weak, it will not harm the good tissue, but neither will it kill the tumor. Incidently, this problem in addition to possessing a high degree of curriculum relevance is quite unlike anything encountered in the training lessons in terms of content or theme.

The other main type of problem included in the criterion batteries is the Minnesota Tests of Creative Thinking (Torrance, 1965). Such problems are quite open-ended with few constraints. This allows for a number of solution-ideas, no one of which can be judged as the most suitable. One example featuring a product-improvement theme requires the child to think of all the ingenious clever ways he can to make a toy dog more fun to play with.

As to the results: in general, the outcomes of the various studies employing the CPSP have been highly consistent. The performance of the instructed children is markedly superior to that of the control children both on the tests of problem-solving ability and on the tests

of creative thinking. (For a detailed report of findings as well as a discussion of scoring procedures, see Covington, 1966c.)

In order to gain a clearer picture of the over-all magnitude of this training effect, consider several performance indices such as total ideas generated, total quality of ideas, mean quality per idea and the incident of principal solutions. Composite scores for each of these indices are computed for every student by summing over his performance on a number of problem-solving tests in the posttest battery, including the X-ray problem. In the same manner a similar set of composite scores are obtained for the tests of creative thinking. On comparing the mean values for the instructed and control groups on any of these composite indices it is found that the instructed groups are invariably superior. In most cases the magnitude of these differences is absolutely large and beyond mere statistical significance. This is illustrated by the fact that when comparing frequency distributions for each composite index, the 50th percentile of the instructed groups typically falls around the 80th percentile for the control groups.

Another way to gauge the degree of educational significance of a training effect is to compare the level of performance of instructed and control children of differing IQ levels. In this connection it has been found (Covington, 1965; Covington, 1966b) that the mean performance of instructed children with IQ's below 99 (mean IQ = 91) is on a par with the mean performance of control children whose IQ's fall between 100 and 115 (mean IQ = 107). This indicates that the administration of the CPSP makes for a substantial boost in the performance of low IQ children over a wide variety of test problems, many of which are curriculum relevant.

To determine how long these training effects persist, a follow-up test battery was given five months after the administration of the posttest in two different studies. These follow-ups included approximately 80% of the fifth-grade children from the original samples who by this time were in sixth-grade classrooms with new teachers. Wherever possible every precaution was taken to insure that the students did not recognize the tests as a part of the earlier work. For example, the children recorded their ideas on regular school paper, rather than in a standard booklet of the kind used in the original study. All the tests were administered by the teacher herself, and whenever possible were introduced as part of the regular classroom work.

In the case of tests of problem-solving ability, the instructed children continued to surpass their control counterparts on the various performance indices, and although the margin of differences had diminished somewhat as compared to the magnitude of effects found at the time of the original posttest, the differences were nevertheless found to be statistically significant. The picture is not as consistent for the tests of creative thinking. In one sample with a total of 180 children, the instructed group was superior to the control group, whereas in another slightly larger sample these differences washed out. It appears that after a five-month interval the training effects are at best marginal in the case of the creative thinking tests. This is not surprising when it is realized that as a group these tests represent a type of problem not directly trained for in the CPSP. Consequently they would be more likely to reflect a greater diminution in

training effect than would the tests of problem-solving ability which are more directly amenable to the kinds of strategies taught for originally.

Issues of Value and Justification

One of the most fundamental questions raised by the present research is whether programs designed to promote creative thinking are actually needed, seen in the perspective of a child's total educational career. No matter how beneficial a given teaching program may be, it is likely that untutored children (the so-called controls) will sooner or later catch up, simply through the normal process of intellectual maturation and accumulating experience. In the present data the sizable reduction in the magnitude of the training effect five months after the administration of the GPSP supports this contention. Of course, it can be argued that more permanent--and in this sense more meaningful--changes will occur only on an accumulating basis, and that what is needed is a program covering a whole school year or even longer, consisting of interlocking, coordinated curriculum units which build on one another. It remains a moot point, without empirical support, yet it would seem likely that a long-range program of increasing scope and complexity designed to stimulate intellectual growth would allow the instructed child not only to maintain a performance superiority, but actually to increase that margin as the program proceeds. While it is true that the trained and the untrained student alike enjoy a natural expansion of intellectual capacities, there is grave doubt that the untutored children would ever make use of their burgeoning capabilities

to the same extent as would children who received systematic long-term training. And, as we have seen, since most elementary school children make scant use of their present capacities for creative thought, there is little reason to believe that these same children at a later age would spontaneously draw on their capacities to any greater degree.

A related point concerns the developmental changes in attitudes and values which favor the exercise of creative thought. While it is quite clear that sheer proficiency in various cognitive skills such as question asking or idea generation is a function of age, there is as yet no evidence that the relevant attitudes and values increase as the child grows older. Thus, even though untutored children may in time overtake the trained children in terms of sheer proficiency, they may be markedly deficient in the very attitudinal dispositions necessary to put such skills to meaningful use. In this connection, creativity training can be designed to provide the student with experiences he is unlikely to receive anywhere else--the challenge of working on a complex but meaningful problem or the sense of satisfaction at discovering a solution--experiences which may affect the child's emerging set of values and attitudes regarding creative functioning. Such experiences, if they occur at decisive points in the individual's development, especially in childhood, may be sufficient to bring him permanently past a critical threshold for actualization of his creative potential. As a matter of fact, we may find in the last analysis that the key to the unlocking of creative potential is to strengthen sets of attitudes and values which predispose the student to undertake creative tasks in

the first place, rather than to start by increasing his sheer competence for performance by means of "skill training."

Future Research Plans

Research plans for the immediate future take two main directions. The first of these involves further development and expansion of the GPSP. In one instance a set of supplementary exercises is being developed to provide additional practice on the various skills and strategies taught in the lessons. These exercises are primarily for remedial purposes and can be used when needed, depending on the rate of progress of the individual learner. Another project concerns the development of a set of "curriculum-link-units," that is, lessons designed to illustrate how the student can apply the skill and strategies taught for in the GPSP to his actual school work in science and the social studies.

The other main direction of research involves the development of new self-instructional teaching units which introduce the student to domains of creative thinking other than problem solving. One obviously important area is that of creative understanding. Here, typically, one is confronted with a series of complex events or occurrences which in the initial phases of investigation often appear to be unrelated. The task is one of discovering meaningful relationships between such events and in some instances of predicting how these events would co-vary under various conditions. In the case of problem solving defined in a more traditional sense, the search is typically of a more limited nature--that of discovering a single workable solution-idea which

satisfies a certain requirement, but often without the necessity of understanding why it works. Such an pragmatic emphasis tends to make for closure once a solution is obtained. On the other hand, creative understanding not only encompasses the discovery of workable ideas, but more often involves an ongoing procedure of checking and re-checking the validity of the proposed solutions against an accumulating set of facts and information.

Another area of creative output, perhaps the one most generally assumed when reference is made to creativity, is that of creative innovation. Here the individual invents or creates new problems, new systems of thought, or new products which did not exist previously. One example of a prototype training unit presently being developed involves the creation of a school play. The story-line concerns some malicious damage done to a barn owned by a local farmer and his unwarranted accusation that a certain boy is responsible. The boy, who is innocent, is able to convince his classmates of the fact, but is unable to prove it to a degree that satisfies the farmer and the rest of the adult community. Understandably the children react with indignation, but at the same time they realize their essential helplessness at being unable to defend adequately their interests in an adult world. While some of the children make plans to track down the real culprit, others decide to express the group feeling of ineffectuality and frustration by means of a play. Parenthetically, such a plot can be used to illustrate that there are other alternatives to the expression of one's emotions besides direct aggression and that intense feelings can serve as a basis for the development of useful and satisfying

products. The particular theme--the plight of the wrongfully accused--was chosen because it sounds a note of high drama and arouses immediate interest and sympathy in children who typically have a keenly developed sense of fair play. Moreover it represents--even when placed in such a simplified context--one of the enduring issues of man and society which demands new solutions from each succeeding generation.

The same general pedagogical devices are used here as in the GPSP. The student is led to develop the play in a step-by-step sequence, while thinking of his own ideas and being provided in turn with appropriate feedback and re-direction of his efforts. In the early lessons the child works through sequences dealing with the creation of the basic plot. The student is encouraged--with the assistance of identification models in the story--to generate ideas which seize on the malicious incident as a point of departure from which to explore the more general implications of being wrongfully accused. This is in contrast to the more pedestrian and common-place approaches of simply dramatizing the boy's innocence or holding the farmer up to ridicule. Basic to the success of this teaching sequence is the introduction of metaphorical and analogical modes of thinking. Once such concepts are grasped by the student he is able to go far beyond a strictly literal interpretation of a situation and can generate a virtually limitless set of implications.

After the outlines of a clever insightful plot are secured, the student explores a number of detailed matters, all of which are important to the final product. In one lesson he creates ideas for the most effective scenery and staging, given a limited amount of material

to work with; in another he is called on to create segments of the dialogue. The last lesson in the series simulates the public reaction to the play which represents a final confirmation of all the preceding activities. Various members of the audience including the farmer and the parents of the accused boy react to the play. There is general recognition that it was worthwhile in its own right as well as being helpful in clearing up a community misunderstanding.

Final Paradoxes and Dilemmas

Inherent in any attempt to teach for creative functioning are a number of dilemmas and paradoxes which give rise to both methodological and theoretical difficulties. In closing we will comment on one recurring dilemma, not because it is necessarily representative or even the most fundamental, but rather because it indicates something of the extraordinary challenges encountered in developing teaching materials for fostering complex cognitive processes. Basic to the act of teaching is a guidance function. To a greater or lesser degree the student's behavior is necessarily guided, shaped and redirected by a teaching authority. The student never has complete freedom. He is exposed only to certain learning experiences, in certain teacher-determined sequences. He is encouraged to talk about these experiences in only certain ways, using prearranged kinds of terminology. If we <u>teach</u> for creative functioning then the child will inevitably be subject to some form of guidance. To the extent that an educational theory stresses the "discipline component" of creative thought, any forthcoming curricula will be more or less restrictive and predetermined.

How then can we reconcile these procrustean-like features of teaching with the fact that in the last analysis creativity is primarily characterized by imaginal freedom and a spontaneous individualization of thought? Perhaps the answer, most simply put, is to teach for structured spontaneity. One technique adopted for this purpose and employed in our current work is to give the student direct practice in discriminating among ideas which are both unique and appropriate to a given task and ideas which are merely bizzare. In such a fashion the student learns to limit the reaches of his spontaneity. Another technique which requires a relatively long-term training program involves comprehensive guidance in the early phases of learning. But, as the child becomes more proficient in the various skills and strategies, the rigid guidance of the program is gradually reduced. In this manner the student comes ultimately to rely on his own resources and initiative with only occasional re-direction from the program. As the student becomes more self-sufficient he can experience yet another dimension of intellectual independence--that of determining for himself which of several creative tasks he will work on from among a number of alternatives. For example, in the case of the creative drama unit just described, the child could be given the option of either writing dialogue or of developing the scenery and staging, once he had completed the introductory units.

All the foregoing implies a complex catering to the individual differences of the learner; first, an intensive close-knit and personalized guidance of the child in the early phases of learning and later, encouragement of self-direction and self-determination. In both

cases the training environment must be capable of selecting, sequencing and coordinating a great many combinations of material. This immediately suggests computer-assisted teaching. The self-instructional format of the current and proposed teaching programs is admirably suited to a computer-assisted operation. Indeed, another facet of the work of the Berkeley group is that of adapting the GPSP for a computer-presentation, thus by-passing the cumbersome booklet format with its limited feedback capabilities. With computer assistance the child can be guided through a much more individualized sequence of learning, dictated by his initial level of competency, his particular cognitive style and his individual rate of progress. Conceptually, it may appear that computers and programmed instruction are antithetical, perhapse even perversely so, to the task of promoting creative thinking. However, such an unlikely juxtaposition points to the kinds of imaginative responses which the educational community must make to the challenge of educating individuals in an increasingly complex and demanding world.

References

Barron, F. The relationship of ego diffusion to creative perception. In C. W. Taylor (Ed.), Widening horizons in creativity. New York: Wiley, 1964. Pp. 80-86.

Campbell, D. T. Blind variation and selective retention in creative thought as in other knowledge processes. Psychol. Rev., 1960, 67, 380-400.

Covington, M. V. The effectiveness of training for problem-solving proficiency and creative thinking as a function of differing ability levels among children. Paper delivered at Western Psychological Association, Honolulu, June 1965.

Covington, M. V. A childhood attitude inventory for problem solving. Mimeographed, 1966. (a) 12 pp.

Covington, M. V. Programmed instruction and the intellectually gifted: experiments in productive thinking. Invited paper, Symposium on Programmed Instruction and the Gifted Child, International Convention of the Council for Exceptional Children, Toronto, April 20-23, 1966. (b)

Covington, M. V. The effects of sex and IQ differences on training for problem solving among school children. Mimeographed, 1966. (c) 38pp.

Covington, M. V., & Crutchfield, R. S. Experiments in the use of programmed instruction for the facilitation of creative problem solving. Programmed Instruction, 1965, 4.

Covington, M. V., Crutchfield, R. S., & Davies, L. B. The productive thinking program. Series one: General problem solving. Berkeley: Brazelton Printing Company, 1966.

Crutchfield, R. S. Independent thought in a conformist world. In S. M. Farber, & R. H. L. Wilson (Eds.), Man and civilization: Conflict and creativity. Part two of Control of the mind. New York: McGraw-Hill, 1963. Pp. 208-228.

Crutchfield, R. S., & Covington, M. V. Programmed instruction and creativity. Programmed Instruction, 1965, 4.

Duncker, K. On problem solving. Psychol. Monogr., 1945, 58, No. 5, Whole No. 270.

Ghiselin, B. The creative process: A symposium. New York: New American Library, 1952.

Hammer, E. F. Creativity. New York: Random House, 1961.

Holt, J. How children fail. New York: Pitman Publishing Corporation, 1964.

Koestler, A. The creative act. New York: The Macmillan Company, 1964.

Luchins, A. S. Mechanization in problem solving: The effects of Einstellung. Psychol. Monogr., 1942, 54, No. 248.

MacKinnon, D. W. Personality correlates of creativity. In Mary Jane Aschner, & C. E. Bish (Eds.), Productive thinking in education. Washington, D. C.: National Education Association and The Carnegie Corporation of New York, 1965. Pp. 159-171.

Mednick, S. A. The associative basis of the creative process. Psychol. Rev., 1962, 69, No. 3, 220-232.

Mandelsohn, G. A., & Griswold, B. B. Differential use of incidental stimuli in problem solving as a function of creativity. J. abnorm. soc. Psychol., 1964, 68, No. 4, 431-436.

Myers, R. E., & Torrance, E. P. Invitations to thinking and doing. New York: Ginn & Company, 1964.

Osborn, A. F. Applied imagination. New York: Scribner's Sons, 1953.

Parnes, S. J. A self-instructional course in creative problem-solving (experimental version). State University of New York at Buffalo, mimeographed, 1965.

Peel, E. A. The pupil's thinking. London: Oldbourne Book Company, 1960.

Upton, A., & Simpson, A. V. Creative analysis. Whittier: Whittier College Press, 1961.

Suchman, J. R. Inquiry training: Building skills for autonomous discovery. Merrill-Palmer Quarterly, VII (1961), 147-169.

Torrance, E. P. Rewarding creative behavior. Englewood Cliffs: Prentice-Hall, 1965.

Footnotes

1. This paper is to be included in H. J. Klausmeier (Ed.), Contemporary research of significance to education, University of Wisconsin, in press.

2. The research reported here is supported by a grant from the Carnegie Corporation of New York under the direction of the author and Dr. Richard S. Crutchfield.